Butler, Missouri
Water Supply Study
City Lake

Up to the present, (January 2002), Butler Missouri has used three raw water sources. These are Miami Creek, Butler Lake, and Marais Des Cygnes River. Sometime during the year 2002, Butler will have completed a new pumping plant on the Marais Des Cygnes River. This plant will have two 2000 GPM pumps. One will be kept in reserve. Miami Creek will be taken off the system, in part because of high concentrations of agricultural chemicals.

The Marais Des Cygnes River diversion and the lake will be the sources of water supply for Butler. Pumping from the Marais Des Cygnes River is shut off when atrazine levels exceed drinking water standards. The diversion will be shut off April through June. Marais Des Cygnes River water will be pumped into the Butler Lake for storing and will then be fed to the treatment plant by gravity flow at up to 1100 GPM. The drainage area at the intake point on Marais Des Cygnes River is 3418 square miles.

Butler Lake is located on a tributary to Miami Creek, about 3 miles WSW of Butler. The lake has a drainage area of 3.11 Square Miles.

For this study, pumping was planned so that the lake level did not fall below 5 to 6 feet below the spillway in order to have a minimum reserve of 400 acre-feet. This study does not consider pumping from mid March through mid July of each year.

Pumping over the last several years has been necessary 4 to 5 months a year. Upstream dams and water uses in Kansas are intensively allocated at other upstream locations for municipal needs, wetland augmentation and cooling for power generation plants.

Upper limits of water available for use from the Marais Des Cygnes River, by Butler, on a monthly basis, was determined by use of a computer program, called STELLA.

As part of this study it was found to be beneficial to analyze base flow and runoff indexes. This was done for the State Line Gage on the Marais Des Cygnes River. The USGS computer program "HYSEP" was used to make this determination. The sliding hydrograph separation method was used. It generates median values of fixed and local hydrograph separation methods. This analysis was made for the period of record from 1959 through 2000. The results of those runs reflect a trend that the base flow is increasing over the evaluation period.

NRCS's computer program "RESOP" was used to make the analysis. Following is the procedure for derivation of data.

STO-AREA Elevation-Storage and Elevation-Area data were determined from July 2000 survey made by USGS.

Butler City Lake

Elevation (feet)	Area (acres)	Storage (ac-ft)
770	0.74	0.57
772	2.18	3.42
774	3.63	9.26
776	6.67	19.07
778	12.66	37.68
780	18.75	69.11

782	24.70	112.18	
784	31.33	1 68.24	
786	37.82	237.08	
788	44.43	319.21	
790	54.24	417.02	
792	63.17	535.91	
794	69.88	668.82	
794.3	71.74	689.95	
795.1	74.77	748.56	Spillway crest elevation
796	77.99	817.32	
798	85.22	980.40	
800	96.48	1159.77	Top of dam

Water surface elevation on 4/18/01 = 793.5

LIMITS Butler City Lake Max. Pool storage 748.56 Ac.Ft.
Minimum Pool storage 15 Ac.Ft.

GENERAL Record period of drought is in the 1950's. Analysis began in January 1951 and ended December 1959.

SEEPAGE Seepage when full was estimated to be 3.5 inches per month and when the pool is near Empty, seepage is zero.

RAINFALL Rainfall data came from the Butler, Mo. rain gage and supplemented where needed with the Appleton City rainfall data.

RUNOFF This is the runoff into the lake from its drainage area. Regional monthly runoff values were determined from stream gage data.

Monthly runoff volumes in watershed inches was determined at the Little Blue River gage near Lake City, North of Butler. Another gage on Cedar Creek near Pleasant View, Missouri was analyzed. Results at the lake were nearly the same. Because the soils and topography of Little Blue River is more nearly like that at Butler, it was selected to represent regional runoff. If runoff did not appear reasonable when compared to rainfall, it was necessary to examine daily rainfall values for that month. Antecedent moisture was estimated for each rainfall event and adjustments to NRCS runoff curve number was made to arrive at runoff for each storm.

EVAP. Pan evaporation at the Lakeside gaging station near the Lake of the Ozarks was used to determine pan evaporation. The adjustment to lake evaporation was 0.76.

DEMAND This was determined by city records. Current usage is 1.01 million gallon per day.

When water level dropped to between 5 and 6 feet below the spillway level, water was pumped to the lake from Marais Des Cygnes River.

OTHER This refers to the volume of water pumped from Marais Des Cygnes River to the Lake.

Determination of the volume of water available for pumping was made using monthly discharges volumes determined by the Computer program, STELLA. The STELLA analysis was based on the stream gage data at Trading Post Gage (drainage area 3230 square miles) and factored up based on drainage area.

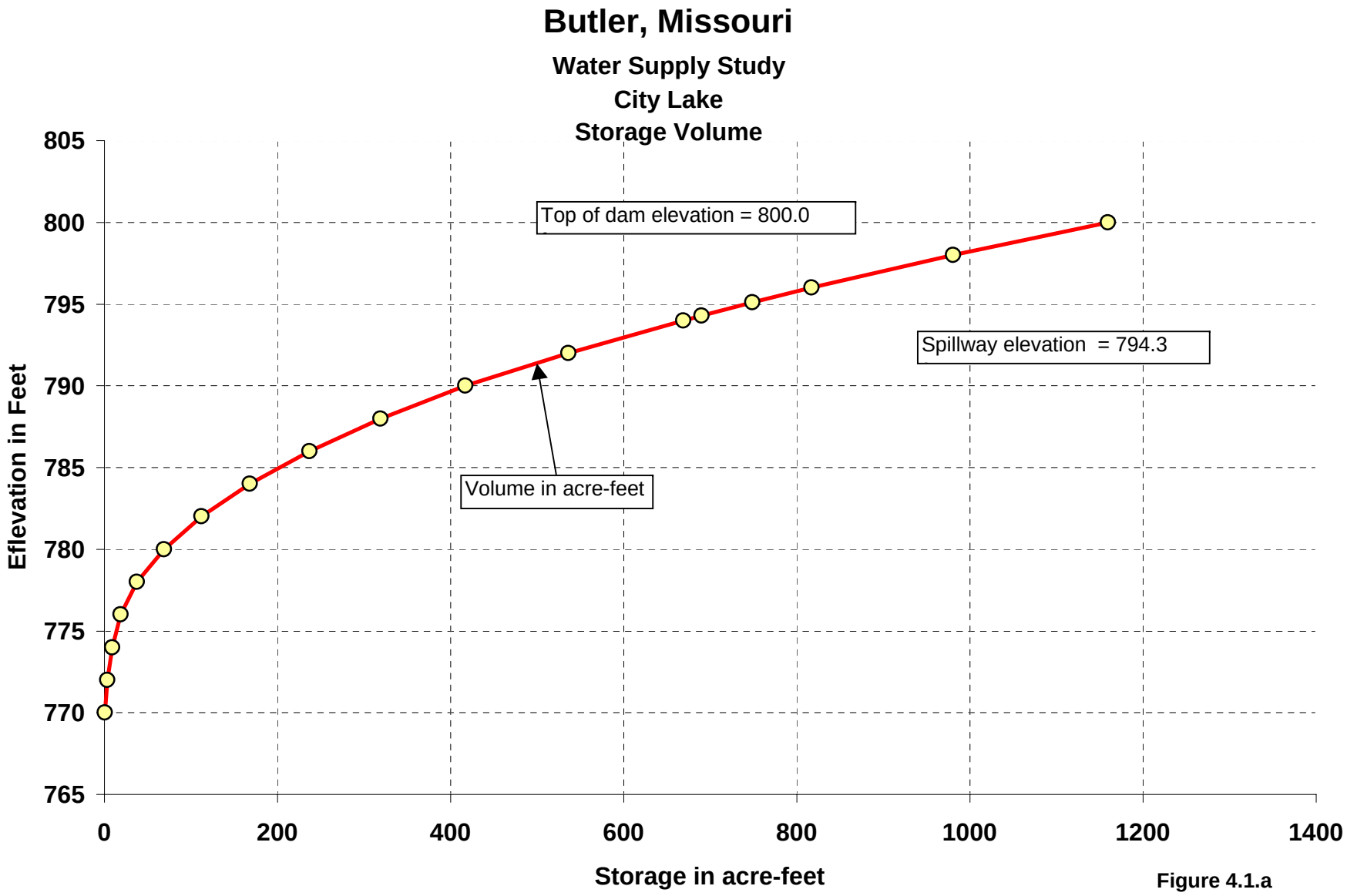

Butler, Missouri
Water Supply Study
City Lake
Storage Volume
Top of dam elevation = 800.0
Spillway elevation = 794.3
Volume in acre-feet
Eflevation in Feet
Storage in acre-feet
805
800
795
790
785
780
775
770
765
0
200
400
600
800
1000
1200
1400

Figure 4.1.a

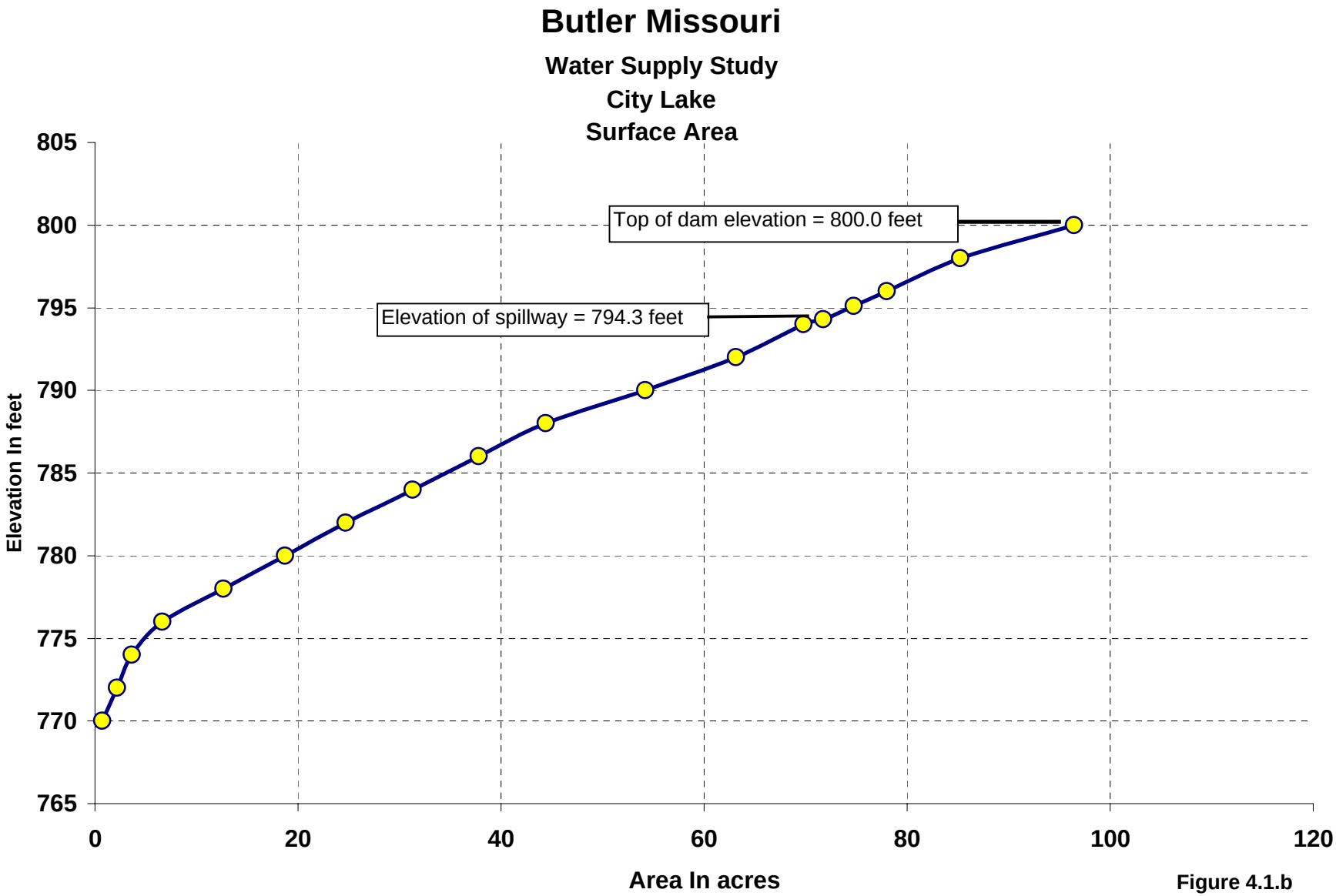
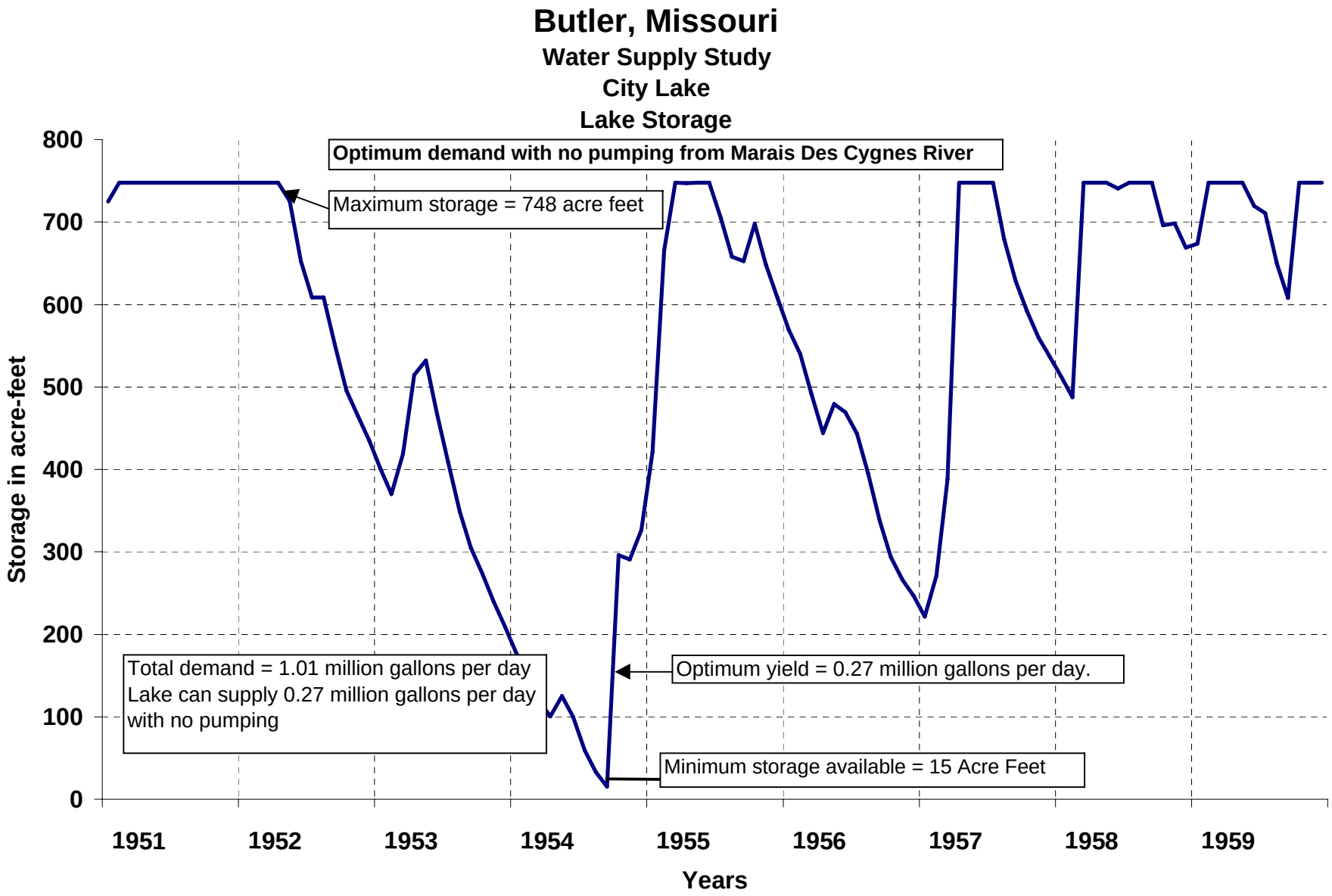
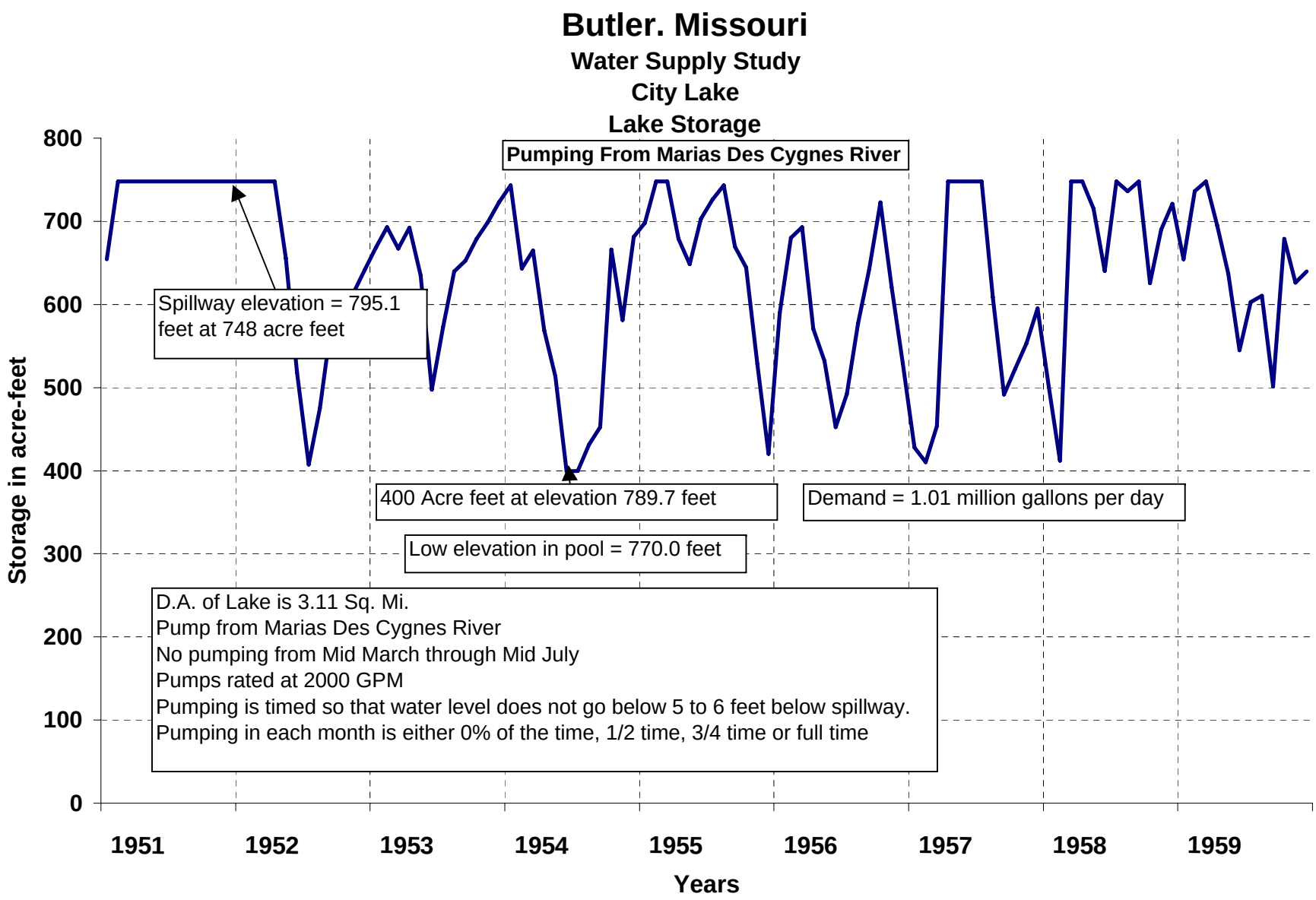

Butler Missouri
Water Supply Study
City Lake
Surface Area
Top of dam elevation = 800.0 feet
Elevation of spillway = 794.3 feet
Elevation In feet
805
800
795
790
785
780
775
770
765
0
20
40
60
80
100
120
Area In acres

Figure 4.1.b


Butler, Missouri
Water Supply Study
City Lake
Lake Storage
Optimum demand with no pumping from Marais Des Cygnes River
Maximum storage = 748 acre feet
Total demand = 1.01 million gallons per day
Lake can supply 0.27 million gallons per day
with no pumping
Optimum yield = 0.27 million gallons per day.
Minimum storage available = 15 Acre Feet
Storage in acre-feet
800
700
600
500
400
300
200
100
0
1951
1952
1953
1954
1955
1956
1957
1958
1959
Years


Butler. Missouri
Water Supply Study
City Lake
Lake Storage
Pumping From Marias Des Cygnes River
Spillway elevation = 795.1 feet at 748 acre feet
400 Acre feet at elevation 789.7 feet
Low elevation in pool = 770.0 feet
Demand = 1.01 million gallons per day
D.A. of Lake is 3.11 Sq. Mi.
Pump from Marias Des Cygnes River
No pumping from Mid March through Mid July
Pumps rated at 2000 GPM
Pumping is timed so that water level does not go below 5 to 6 feet below spillway.
Pumping in each month is either 0% of the time, 1/2 time, 3/4 time or full time
Storage in acre-feet
800
700
600
500
400
300
200
100
0
1951
1952
1953
1954
1955
1956
1957
1958
1959
Years

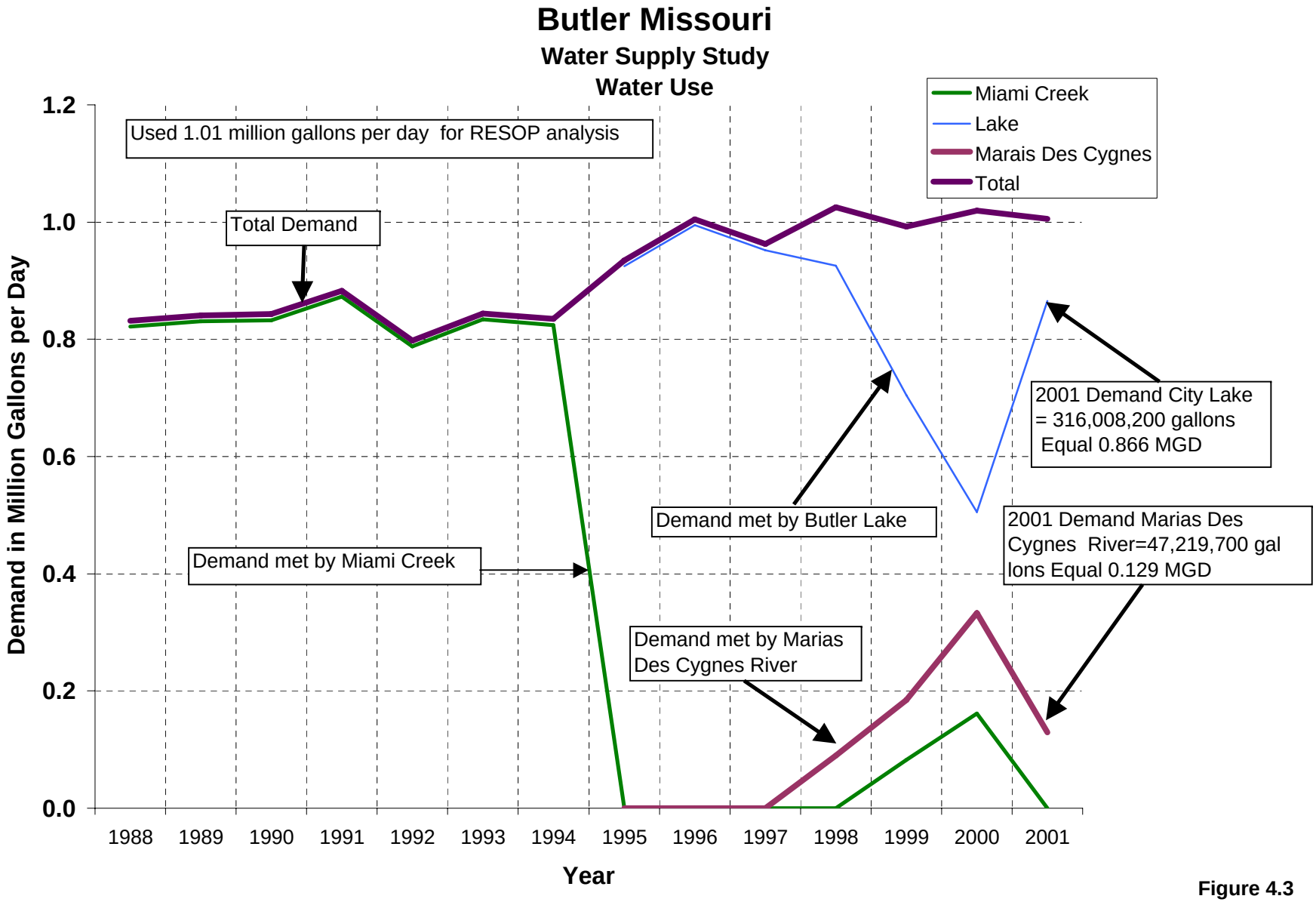
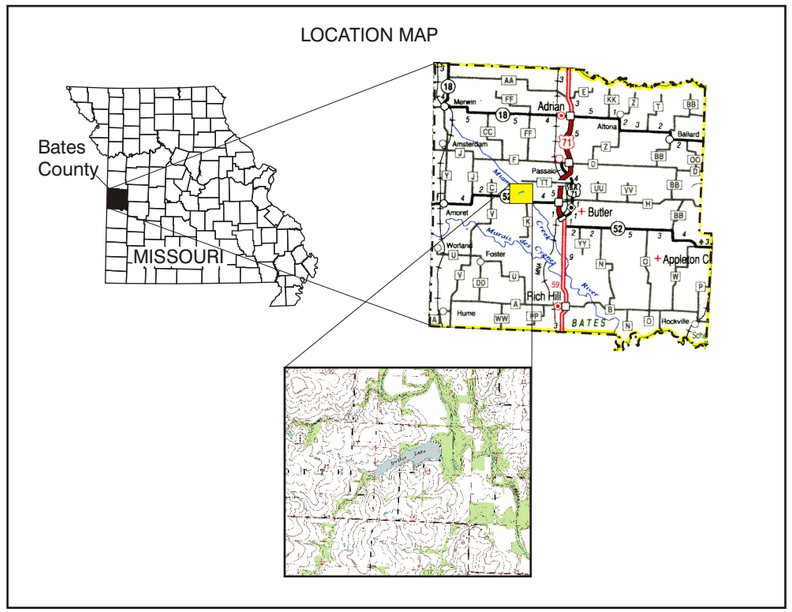
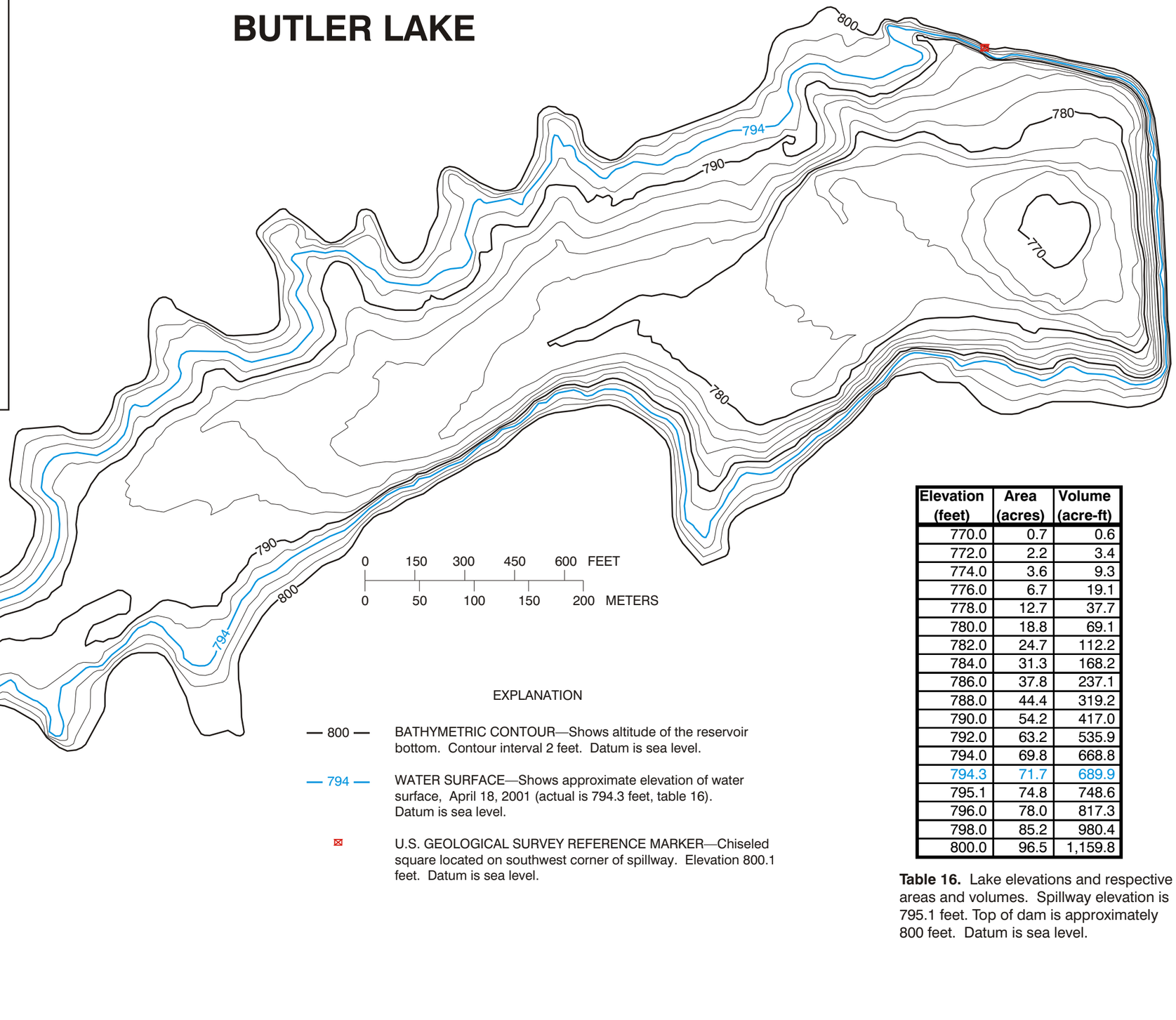

Butler Missouri
Water Supply Study
Water Use
Used 1.01 million gallons per day for RESOP analysis
Total Demand
Demand met by Miami Creek
Demand met by Butler Lake
Demand met by Marias Des Cygnes River
2001 Demand City Lake = 316,008,200 gallons Equal 0.866 MGD
2001 Demand Marias Des Cygnes River=47,219,700 gallons Equal 0.129 MGD
Miami Creek
Lake
Marais Des Cygnes
Total
Demand in Million Gallons per Day
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Year

Figure 4.3

BUTLER LAKE





Elevation (feet)	Area (acres)	Volume (acre-ft)
770.0	0.7	0.6
772.0	2.2	3.4
774.0	3.6	9.3
776.0	6.7	19.1
778.0	12.7	37.7
780.0	18.8	69.1
782.0	24.7	112.2
784.0	31.3	168.2
786.0	37.8	237.1
788.0	44.4	319.2
790.0	54.2	417.0
792.0	63.2	535.9
794.0	69.8	668.8
794.3	71.7	689.9
795.1	74.8	748.6
796.0	78.0	817.3
798.0	85.2	980.4
800.0	96.5	1,159.8

Table 16. Lake elevations and respective areas and volumes. Spillway elevation is 795.1 feet. Top of dam is approximately 800 feet. Datum is sea level.

USGS
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Figure 16. Bathymetric map and table of areas/volumes of Butler Lake near Butler, Missouri.

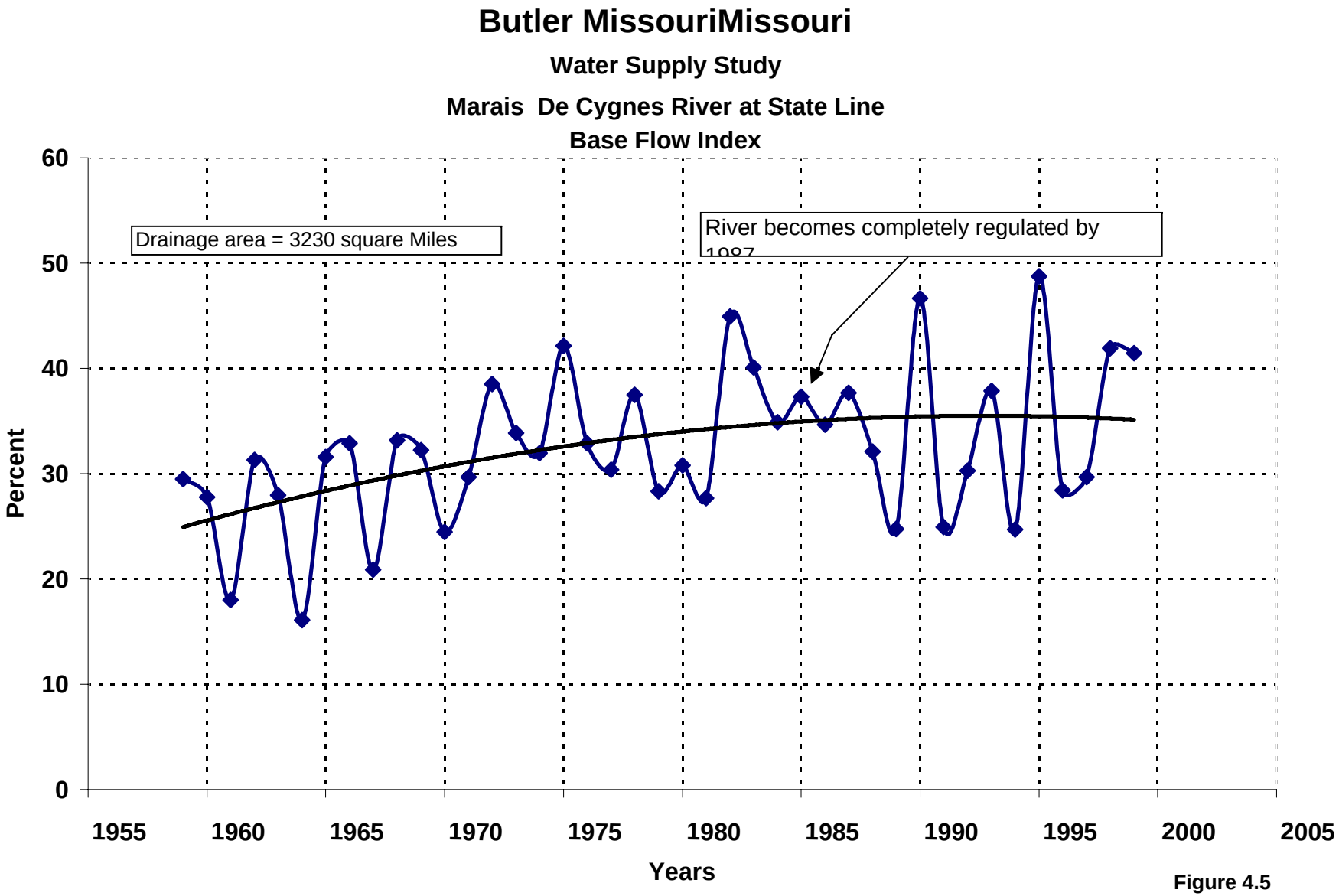
Butler MissouriMissouri
Water Supply Study
Marais De Cygnes River at State Line
Base Flow Index
Drainage area = 3230 square Miles
River becomes completely regulated by
Percent
60
50
40
30
20
10
0
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Years

Figure 4.5

Butler, Missouri

Water Supply Study

Marais Des Cygnes River

Percent of Flow Pumped

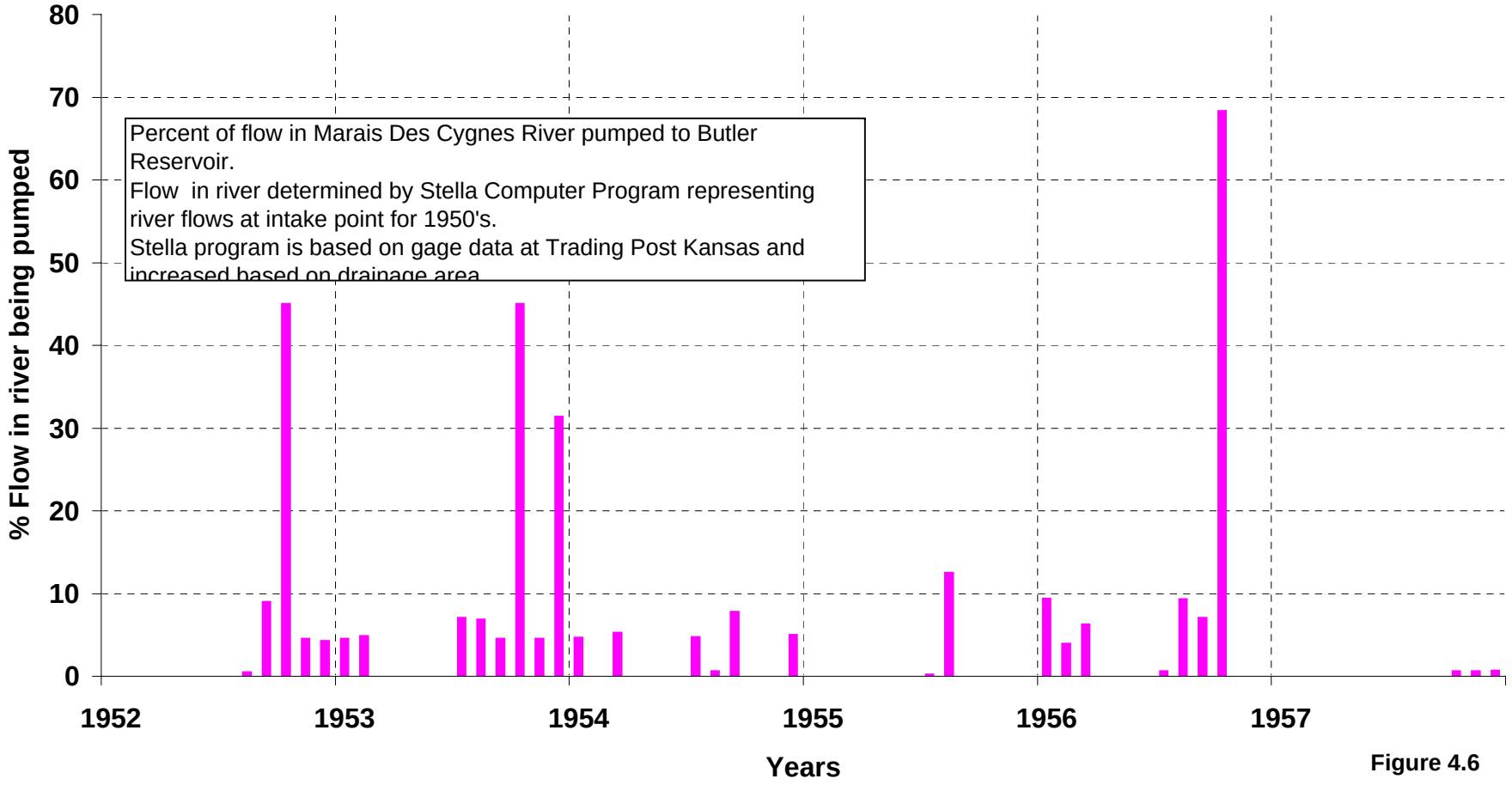

Figure 4.6